



WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Climate Change and Water Use/Availability in Maine

Focus Categories: CP, DROU, ECON, HYDROL, M&P, WQL, WQN, WS, WU

Keywords: Climate, Conflict Management, Drought, Hydropower, Information Dissemination, Irrigation, Water Resources.

Duration: 3/1/00-2/28/01

Federal Funds Requested: \$14,075

Non-Federal Funds Pledged: \$22,355.

Principal Investigators: John Peckenham (Water Research Institute), J. Steve. Kahl (Water Research Institute), and Robert M. Lent (United States Geological Survey).

Congressional District: Second

Statement of Critical Regional Problem

There are several important inter-relationships between potential climate change and water resources. These relationships are important policy and planning issues, due to our poor ability to predict climate change and the natural variations in weather that occur over the period of years. For example:

1. What are the predicted regional effects of climate change?
2. How will these changes affect Maine's water resources and supplies?
3. What will be our water requirements in the next two decades?
4. Are there conflicts with current water resources and what new conflicts can be expected?
5. How do we evaluate the need for alternative water supplies?

Maine's economy has a critical dependence upon its water resources with 1,542 square miles of lakes and ponds, 31,672 miles of streams and rivers, and 5,249 miles of coastline (MDEP, 1996). This includes water supply for consumers, hydropower impoundments, freshwater fisheries, and transportation. Recreationally, aesthetically, and economically, Maine's 6,000 lakes are important features that alone contribute billions of dollars to the state economy (Boyle *et al.*, 1997). Subtle changes in regional climate such as changes in

the frequency and intensity of rainfall can have a profound affect upon key water resources.

According to summary data from the National Weather Service in Gray, Maine there have been record setting temperature extremes and rainfall events over the last five years. This includes higher than normal temperatures, drought, and intense rainfall. These changes in weather patterns affect the management of hydropower; i.e. balancing water input with power demands as drought periods increase in length and storm intensity increases. Water consumers are impacted from drought induced stresses on water quality and quantity. Freshwater fisheries are stressed by drought conditions and degradation of water quality due to increased runoff during intense storms, and spring spawning runs could be nonexistent without ample snowpack melting. The fisheries are already under stress on many major rivers in Maine, and recovery efforts are hampered by climatic change.

Statement of Results and Benefits

The Climate Change and Water Use Workshop will be a meeting between climate change researchers (*e.g.* NWS/NOAA and University), water scientists (USGS and University), emergency management agencies, state water-related agencies, hydropower companies, agricultural agencies, and fishery-related agencies. The goal is to have this informational sharing meeting result in a draft action plan that identifies key indicators that should be monitored and what actions should be taken when the key indicators change. As an example, we need to determine the balance between maintaining a water impoundment for power production and minimum base flow in a river for fisheries management when there are drought conditions. Another example is determining how many acre-feet of water can be drawn from rivers for irrigating blueberry land when salmon are spawning. Some aspects of water management have been addressed already on an issue-by-issue basis without examination of the broader scale problems. Obviously, some issues may not be resolvable during this workshop and research objectives will be developed in lieu of an action plan.

Part of this proposed effort will involve organizing the workshop. The first step will be assembling the information on the state's water resources and recent streamflow trends (USGS), weather trends (NWS/NOAA), and climate model projections. The organization committee will then determine what information will be most useful for the workshop. The tentative structure is to have the workshop take place over two days. The first day will be devoted to information transfer with presentations on climate trends, weather patterns, existing water resources, and projections of future demand. Probably this will include presentations from agencies collecting weather and water data and from researchers. The workshop participants will then form working groups according to their specialty (water supply, hydropower, agriculture, fisheries, recreation, etc.). The working groups would meet in the evening of Day 1 with an informal agenda to analyze the presentations and prepare an agenda for Day 2. The second day will start with the working groups preparing draft action plans that will be presented to all participants in the afternoon of the second day. The end result being an exposition of what we know

about water resources and weather trends followed by an inventory of what information is needed by each water resource sector. Finally, the results need to be merged into a format so that competing needs can be assessed. It is unrealistic to expect that a consensus will be reached over the course of two days and each working group will need to set a deadline (i.e. 1-month) for finalization of a draft action plan.

After the draft action plans are completed, the Water Research Institute will prepare a summary of the meeting proceedings and a compilation of draft action plans for all participants. This will be followed by a presentation to the Drought Task Force on how to implement the workshop results as a strategic action plan. The Water Research Institute and the USGS will provide technical support as the Drought Task Force debates policy issues. In summary this proposal will form the basis for organizing a workshop and resultant draft action plan that will be a template for managing Maine's response to weather and climate-induced changes of our water resources. It will provide an opportunity for the main providers of basic information on water resources (USGS) and weather/climate (NWS/NOAA) to work closely with the key people involved in water management policy in Maine.

Nature, Scope and Objectives of the Research

Alteration of weather patterns, possibly indications of decade-long changes in climate, have been very noticeable in the last two years. These changes have lodged themselves in the popular press as these news excerpts from the Maine Climate Change web page (www.downeast.net/nonprof/cse/climate.html) and other sources reflect:

- Record low snowfall for state (*Bangor Daily News*, January 10, 2000)
- Record heat in our region, nation, and internationally . Over 271 people dead in US from two heat waves. (*Bangor Daily News*, August 10, 1999)
- 105-year April-July record drought in MD, NJ, DE and RI. Second driest April-July in NY, CT, MA, and WV, third driest in ME. -- (*Bangor Daily News*, August 12, 1999).
- Federal emergency aid sought to help drought-stricken farmers in the state. (*Portland Press Herald*, Saturday, August 14, 1999)
- Record low ground water in central, western and eastern Maine according to US Geological Survey. (*Bangor Daily News* August 5, 1999)
- Dry spring and summer in region lowers hydropower production, blueberry and corn yield, increases irrigation, lessens boating recreation. (*Bangor Daily News*, April 16, 1999)

- 14 out of 16 Maine Counties declared eligible for drought relief. (*Bangor Daily News*, August 26, 1999)
- Arctic temperature has risen 1.5 degrees C since 1965; Inuit food supply disappearing;. Polar bears are dying and having fewer cubs as ice thins. (*The Mail and Guardian*, 8/6/99)
- Case of malaria from mosquitos reported in MI and CT in the 1990s for the first time ever.

According to a study commissioned by the Pew Center on Global Climate Change (Frederick and Gleick, 1999), climate change will have a profound effect on water resources. In particular they predict changes in water quality due to changes in storm intensity, runoff duration, and water temperature. An evaluation of climate models by the U.S. Geological Survey (Wolock and McCabe, 1999) unveiled a range of uncertainty regarding changes in precipitation and runoff (increase or decrease). Either result would affect water resources in a profound manner. The scientific data supports some of the media coverage of climate change effects. According to Robinson and others (1993), the snow pack in higher latitudes has been smaller and snowmelt runoff has been less in the last two decades. Nicholls and others (1996) noted that in recent years there has been earlier lake ice melting, earlier snowmelt flooding and earlier land warming in high latitudes. The discrepancy between local weather and climatic factors may be explained by the scale of the climate models (large areal blocks and decades of time) compared to weather systems (local effects and time periods of hours to days) (Frederick and Gleick, 1999). The implication of these studies is that weather patterns have changed and will continue to change. According to climatic data analysis (NOAA, 1999; Kahl, 1995) changes already affect our region's water resources through extremes in rainfall intensity (24-hour record set in September 1999), drought (summer of 1999) and mean temperature (April through November 1999).

The changes in weather patterns and short-term climate in Maine have a direct and measurable relationship with water resources. This includes the mass balance of the hydrologic cycle, the timing of demand and recharge, the maintenance of flowing rivers, the ability to support fisheries, hydropower production, and water-related tourism. When totaled, the state's water resources account for billions of dollars of the economy. The stakeholders are not prepared to react to all the changes in water resources and it is expected that demands on these resources will only increase over the next decade (Frederick and Gelick, 1999).

In order to manage the human response to climate-induced changes it is crucial to bring together the stakeholders and the researchers evaluate the resources needed to develop a strategic action plan. The Water Research Institute at the University of Maine and the U.S. Geological Survey-Water Resources Division propose to sponsor a Climate Change and Water Use Workshop to develop the criteria for dealing with water resources at risk and to formulate a draft action plan for the next decade. Although the primary benefactor will be the Drought Task Force, the plan will become a basic tool for helping state

agencies and water resource managers to deal with weather extremes and climate-induced changes to our water resources. Additional support is expected from the National Weather Service. This pro-active approach to managing the impact of weather and climate changes has never before been applied in Maine.

The Climate Change and Water Use Workshop will be the first organized attempt in Maine to look beyond problem identification and apply research to generate management objectives. To accomplish this project it is necessary to bring together the research community, regulatory agencies, and resource managers so that information can be shared and water resource objectives be melded into a common action plan. The potential scale of water resource change could have a tremendous negative impact on all stakeholders. The scope of the workshop should be broad enough so that the participants can identify how these critical resources can be shared for mutual benefit, or at least minimizing mutual loss.

Our objectives are:

1) To identify the key researchers on climate change and weather patterns.

It is essential to get as clear a prediction of decade-scale trends as possible. The USGS is the primary provider of water resource measurements and the NWS/NOAA is the primary provider of weather and climatic data. There are researchers in Maine and the northeast who have particular expertise on climate changes (temperature regime, moisture regime, seasonal changes, etc.). This will be the opportunity to get the most current interpretations of trends to the stakeholders.

2) To enhance communication among stakeholders.

Changes to the quantity or quality of water resources will affect everyone in the state. If trends in water resources cause stress to natural systems, then there will certainly be secondary sociological stress. Since water resources are something that is common to an otherwise diverse and disjointed population, this workshop will be the first step in forging new management strategies. This workshop will give key stakeholders an opportunity to work together to develop a strategic plan to respond to the stresses.

3) To develop a draft strategic action plan.

The University of Maine WRI is taking the lead to foster water resource educational efforts in the state. The workshop will result in a draft action plan for the Drought Task Force that can be used to manage our collective response to changes in the water resources. As a management tool, it is more effective to have a response action plan with some uncertainties than no plan and a certainty of unclear action.

4) *To develop a framework for future action.*

Once this workshop is complete, a summary of proceedings and a draft action plan will be prepared. The workshop organization will be a template for future workshops if deemed necessary by the stakeholders.

Methods, Procedures and Facilities:

Procedures

This proposed work will be divided into three phases: (1) workshop organization and operational management, (2) workshop facilitation, and (3) editing of proceedings for publication. WRI and USGS staff will take the lead in workshop preparation, including forming an organization committee to solicit contributors for the technical presentations and identification of key stakeholders (Phase 1). This includes devising the program, soliciting contributions to the program, advertising the meeting through direct mailings, the WRI Web Page, and others means. WRI, USGS, and the organization committee (Phase 2) will manage workshop facilitation. This includes securing physical space for the meeting and solving logistical problems during the workshop. Following the meeting the WRI will collate and publish proceedings of the workshop, including the draft action plan to be developed (Phase 3).

Facilities

The workshop will be scheduled to occur in mid-summer so that University of Maine facilities can be used for meetings and lodging. This arrangement will also allow participants to familiarize themselves with resources available at the university.

Committee

An *organization committee* is proposed to oversee the workshop and to ensure that this effort is brought to a successful conclusion. This statewide group will include representatives from the federal and state regulatory agencies, water utilities, and hydropower companies, U.S. Geological Survey, National Weather Service, as well as members at the University of Maine staff and associated faculty of the Water Research Institute.

The organization committee will be formed from key stakeholder groups. The Drought Task Force will be the primary beneficiary of this workshop and its membership will be used as a basis for forming the organizing committee. Membership on the task force (Table 1) is from a diverse cross-section of regulatory agencies and businesses.

TABLE 1. Drought Task Force Membership

David Breau	DHS, Drinking Water Program
Steven Burgess	Maine Emergency Management Agency
Mark DesMeules	State Planning Office
Bob Devlin	Maine Municipal Association
Harry Doughty	Department of Conservation
Francis Drake	DHS, Drinking Water Program
Shelley Falk	Department of Agriculture
Rachel Fisher	U.S. Army Corps of Engineers
Wes Hallowell	Florida Power and Light
Ray Hammond	Public Utilities Commission
Tom Hawley	National Weather Service
Steve Kahl	Water Research Institute
Ruth Kitowicz	U.S. Army Corps of Engineers
Robert Lent	U.S. Geological Survey
Steven Levy	Maine Rural Water Association
Chris Lockwood	Maine Municipal Association
Marc Loiselle	Maine Geological Survey
Jeff Martin	Great Northern Paper Company
Jeff McNelly	Maine Water Utilities Association
Brent Mullis	Consolidated Farm Services Administration
Dana Murch	Department of Environmental Protection
Joe Nielsen	U.S. Geological Survey
Tom Parent	Department of Conservation
Arnold Roach	Consolidated Farm Services Administration
Clough Toppan	DHS, Health Engineering

The University of Maine Water Research Institute and USGS will provide the oversight of this Committee. In addition to the Drought Task Force, potential membership for this committee will be derived from these organizations or agencies:

- U. S. Geological Survey
- Maine Geological Survey
- Maine Emergency Management Agency
- Maine Department of Agriculture
- Maine Department of Environmental Protection
- Maine Department of Conservation
- Maine Department of Inland Fisheries and Wildlife
- Maine State Planning Office
- National Weather Service

- Consolidated Farm Services Administration
- U.S. Army Corps of Engineers
- Paper Products Industry
- Penobscot Nation
- Hydro-Power Industry
- University of Maine, Water Research Institute
- Maine Water Utilities Association

Specific groups with water resource interests that do not participate in the organization committee will be invited to participate in the workshop. This may include out of region experts and citizen action groups.

Related Projects:

Previous Climate Change Meetings hosted by the University of Maine. In 1993 the Water Research Institute at the University of Maine sponsored a program entitled, A Regional Response to Global Climate Change: New England and Eastern Canada. This conference was attended by 135 natural resource managers, scientists, and policy makers from New England and Eastern Canada. Nine areas of the regional economy were identified as being sensitive to global climate change.

1. Fisheries
2. Forestry
3. Agriculture
4. Tourism and Recreation
5. Energy
6. Wetland Ecosystems
7. Coastal Infrastructure
8. Water Resources, and
9. Human Health.

The conference attendees proposed an action plan to address climate change:

1. Diversify the natural resource based economy,
2. Reduce risks to human health, ecological communities, and economic infrastructure, and
3. Develop and share information on climate change issues.

Specific issues needing attention were identified to clarify the three recommendations. Conference presentations and conclusions were summarized in a proceedings volume. The implementation of recommended policy changes has been very limited.

Other Climate Change Conferences in Maine. Pam Person (Coalition for Sensible Energy) co-chaired the "Climate Change in Maine - The Risks and Opportunities" conference in April 1999 in Lewiston, Maine. The conference had participation from 50 sponsoring organizations, 43 members on the Planning Committee, over 70 speakers and 300 attending with great representation from all sectors. There were speakers from diverse groups- United Technologies (corporate as well as the Maine Pratt and Whitney plant), Maine Chamber and Business Alliance E2 Center, Shaw's Supermarkets, J.D. Irving Corporation, Champion International, J.M. Huber, Bangor Gas, the American Petroleum Institute, Maine Oil Dealers, solar and wind energy producers, Independent Energy Producers of Maine, Bangor and Aroostock Railroad, Maine Organic Farmers and Gardeners Association, Maine

Snowmobile Association, Northeast Energy Efficiency Partnerships, The Colony Hotel, the Snowmobile Association, and the Canadian Home Builders Association, Brunswick Naval Air Station, Town of Wells, City of Portland and representatives from the Maine congressional delegation. Agencies, academic institutions and non-governmental organizations were well represented. Information was shared on agriculture, climate

change, sea level rise, marine resources, ecosystem effects, recreation, economics, industrial energy efficiency. A Proceedings volume summarizing most of the talks was given to each conference attendee. Actions initiated at this meeting are continuing.

Climate Change and Water Resources in New Brunswick, Canada. The New Brunswick government has been examining the effects of climate change and extreme weather events on their water resources (B. Burrell, New Brunswick Committee on River Ice and the Environment, personal communication, December 1999). Of special concern is the Saint John River and the sensitivity of river ice and flooding to climate change. The government has identified areas that will need to be assessed in response to anticipated climate changes, such as: bridge engineering, cold-water fish survival, ice jam flooding, drinking water quality, and coastal flooding.

There is a wealth of weather and climate data available for Maine that is accessible via the internet. These data include real-time weather and stream flow, as well as historical data going back several decades. These resources are the most important part of the water management process.

The U.S. Geological Survey measures snowfall and streamflow in a variety of locations in Maine. These measurements are available in real-time (<http://aug1dmeags.er.usgs.gov/>) and compiled data covering multi-year records for specific stations can be viewed or downloaded. Finding this information and learning how to use it will be an important part of the workshop.

The National Weather Service monitors atmospheric conditions and makes projections about weather in the near term (hours to months). The data used to predict weather and

measurement of weather conditions (including remote sensing) are available via the internet (www.nws.noaa.gov/er/gyx/main_menu.shtml). The type of information available here that is of greatest importance is prediction of storm events and compilation of weather extrema.

Weather data from weather observations collected over many years are the basis of climate data. Assessing how weather variation can reflect climate change is a complex problem. The objective of using climatic data is to look at long-term trends to help predict the future. In this instance, the focus will be on water resources. Climatic data is accessible via the internet from the Northeast Regional Climate Center at Cornell University (<http://www.cit.cornell.edu>).

References

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